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25X1A

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[redacted]

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30 July 1968

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P68-3 and D68-15

FINAL REPORT

Evaluate Multi-Format Data Block Reader

9 July 1968

25X1A

Prepared by:

[redacted]

25X1A

Approved by:

[redacted]

Date: 18 July 1968

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FOREWORD

The multi-format data block reader was evaluated to determine performance and reliability with respect to various inputs and other operating conditions. The evaluation included:

a. The testing program

b. Maintenance and service.

c. Operational considerations.

Evaluation was made from the standpoints both of analysis testing (P68-3) and equipment performance (D68-15) considerations. These separate aspects have been combined in this final report. This document is intended to be useful both to those who may use and maintain the equipment as well as those involved in design or construction of similar equipment.

P68-3 and D68-15

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SUMMARY

Provided that necessary conditions are met with respect to preparation of film materials and adjustment of equipment, performance of the

25X1A [redacted] Data Block Reader is as good as indicated by the manufacturer.

25X1A While the [redacted] Reader can perform reliably, it is a complex instrument. Our experience has shown that materials used with the equipment must be carefully prepared. Additionally, corresponding lamp adjustments and film alignment for the different code formats require a trained operator to assure their being made properly.

The reader was used to determine reproduction and operating conditions that provide maximum readability with the pertinent data code formats. Its performance was evaluated under a variety of conditions using the materials obtained from several different camera systems.

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TITLE: Evaluate Multi-Format Data Block Reader

TASK

1. Determine technical and operational feasibility of using the 25X1A [redacted] Data Block Reader in future systems. When making this evaluation:

a. Read the data blocks on several rolls of test film with 25X1A the [redacted] instrument.

b. Obtain densitometric data on the data block for various levels of development.

c. Write a computer program for use in analyzing errors in data block readout.

d. Effect liaison with [redacted] for assistance with machine operation and maintenance. 25X1A

INTRODUCTION

25X1A 2. A [redacted] Data Block Reader was made available for extensive testing and evaluation. The equipment was demonstrated, and operators were trained by a representative from the manufacturer's organization. Performance of the reader was tested under a variety of conditions using a wide range of input materials. These tests aimed at determining conditions for maximum readability with all the operational films containing code formats for which the reader was designed.

DISCUSSION

3. General Description. The Multi-Format Data Block Reader is designed to read photographic data from film, principally the dot codes and a few binary bar codes. It records these data on magnetic tape. The reader is housed in two rack type cabinets. One double slope-front cabinet contains the controls, a film transport with spindles (adapted for 35mm to 9.5-inch precision spools) and a code reading head. The other cabinet contains the magnetic tape transport and recording head. The reader is illustrated in Figure 1.

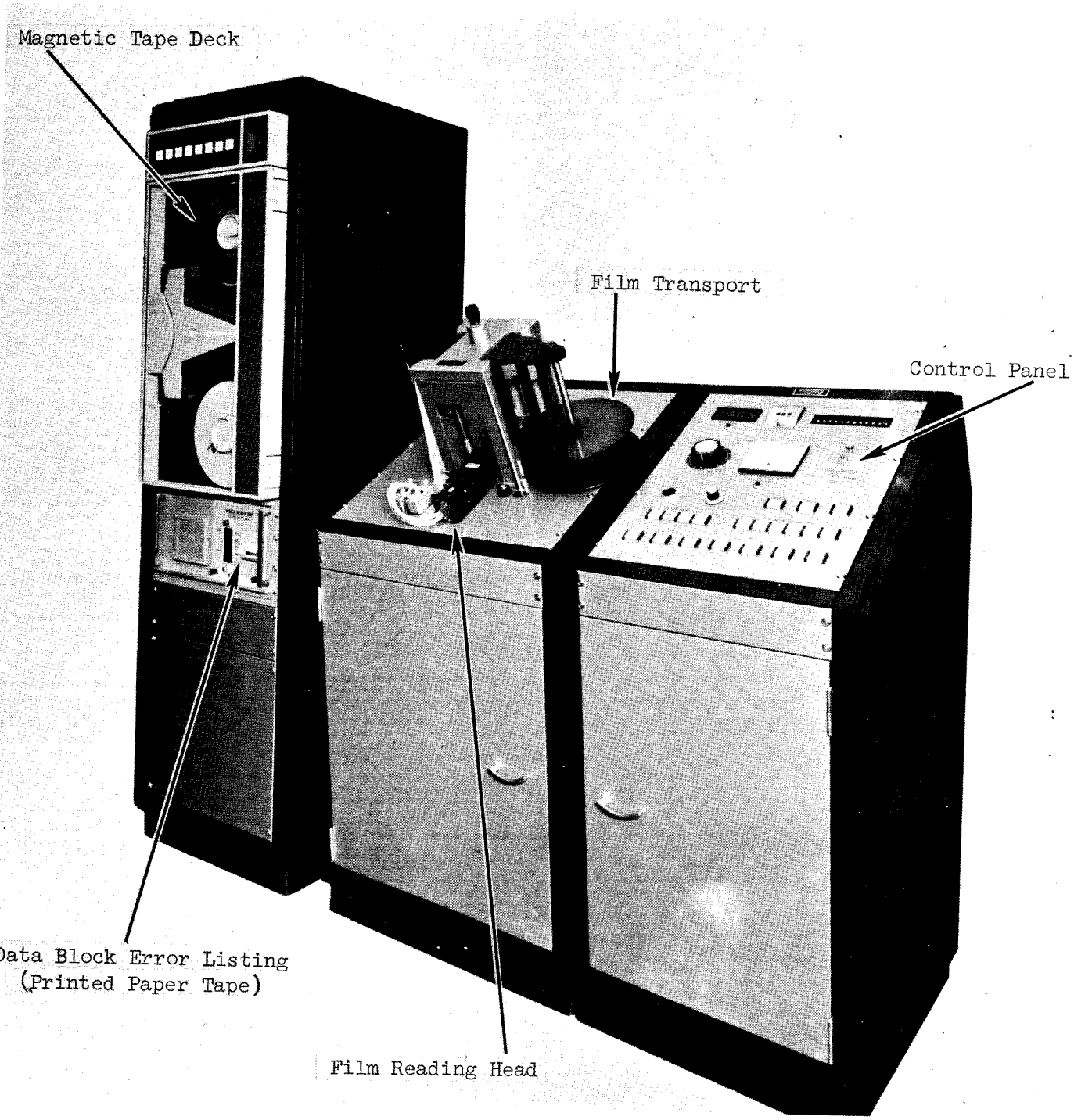
4. Mode of Operation

a. Reading and Recording

(1) Code block formats are read, one line of data dots at a time, by a row of photo-voltaic cells. The cells are illuminated by collimated light passing through the film from a projection lamp source.

Figure 1

25X1A [redacted] Multi-Format Data Block Reader



These cells are positioned near the film edge in a row perpendicular to the film-edge plane. The code reading cycle includes "searching" for the first dot, called the index dot. (The code dots range from .006 inches to .010 inches in diameter.) Because code block position accuracy will be influenced by the transport wander of film slitting, camera acquisition, printing, and reading systems, the reader was constructed to accommodate a combined wander tolerance of ±.030 inches.* As the film is transported past the reading head each line of data is picked up and stored in electronic logic circuits until the full block is read. The block is then rearranged by the logic into a computer compatible code which is in turn placed on the magnetic tape.

(2) The magnetic tape can then be transferred to a programmed computer where the binary dot data is transformed into an alphanumeric message.

b. Error Indicator. An indication of the reader's performance with any particular roll of material can be obtained by observing the printed paper tape output. This paper tape error indicator, located below the magnetic tape deck, lists frame numbers which correspond to incorrect data block readings. It does not indicate the particular bit or bits which caused the error, but it does specify which frame(s) must be rerun or examined visually for data accuracy. A series of trouble lights located on the control panel assists in determining the nature of the reading errors (such as parity error, incomplete data, excess wander, etc.)

c. Adjustments. Two important adjustments, lamp intensity and index dot alignment, are required to obtain maximum readability with different types of materials.

(1) Intensity of the light source can be varied by adjusting the intensity control knob on the front panel of the reader.

(2) Proper alignment of the index dot is accomplished by rotating the control knob which centers the index dots between the two reticle lines on the positioning scope.

5. Test Program

a. Preliminary Investigations. The [redacted] code reader used in the test program was designed to handle 12 different data code

25X1A

*For "searching out" the first index dot.

P68-3 and D68-15

formats. An examination of code descriptions revealed that only 5 (of the 12 readable formats) were currently operational (see Figure 2). An initial evaluation of the reader, using materials generated from some of these pertinent photographic records, revealed the following information:

One obsolete - 6 - SR-71 Systems

25X1A

(1) The [redacted] reader will read both positive and negative data code images and will operate with the film being transported in either the forward or reverse direction.

(2) The reader has a preference for negative type imagery (i.e. black dots on a low density surround). These findings verify information from the vendor.

(3) Although the reader operates better with negative imagery, valuable original negatives must never be used with this machine. The optical glass "turtle back" film transport device will probably scratch the material.

(4) Consistently accurate code reading depends on light of equable intensity. A regulating type transformer was placed in the projection lamp circuit, to insure steady line voltage, and removed upon completion of reader testing.

Note

b. Test Materials. Several different types of negative materials were obtained for test purposes. These were samples which had been exposed in the various operational camera systems coinciding with the readable formats. Portions of these materials were processed at different levels of development and spliced together to prepare operational master test rolls. In all cases the different levels of development included the current standard level(s) for each film type and camera system as well as one section processed to an excessive underdevelopment condition. Microdensitometer traces of selected dots from each of the different types of materials were compared with MIL-STD-728B to determine the positioning and quality of the dot images for use in the data block test program. An example of the differences found in dot density profile is shown in Figure 3. These two traces of Format 12 test material represent extreme original negative process

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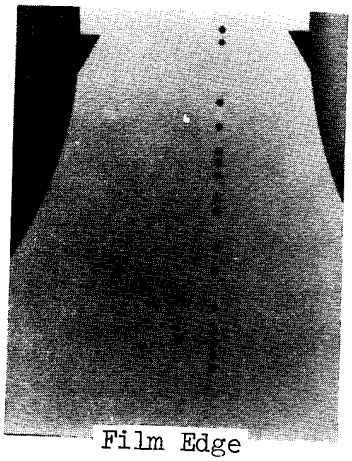
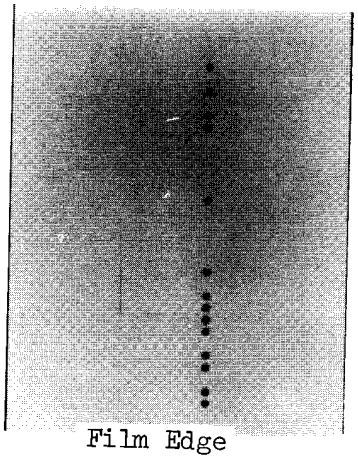
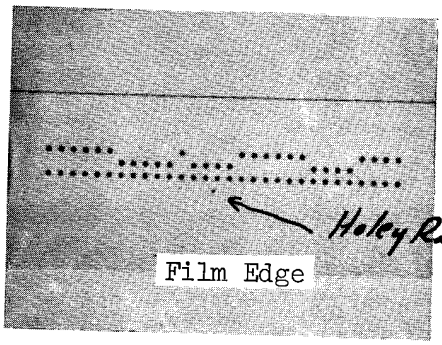


Format 1



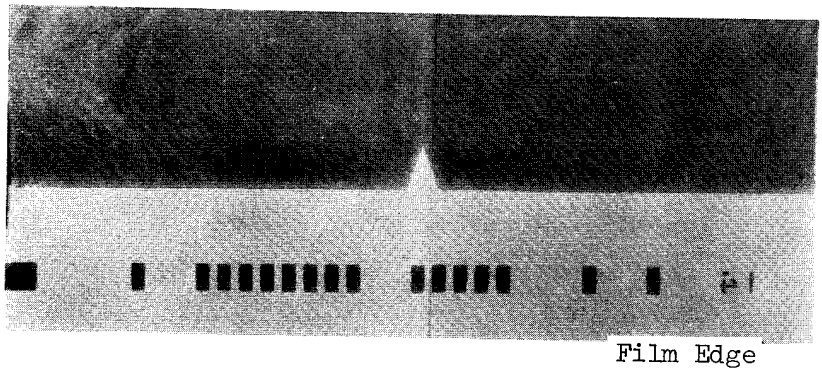
Format 2



Format 12

Figure 2

Data Block Formats for
Operational Systems
(3.5X enlargement)



Format 9

Format 10

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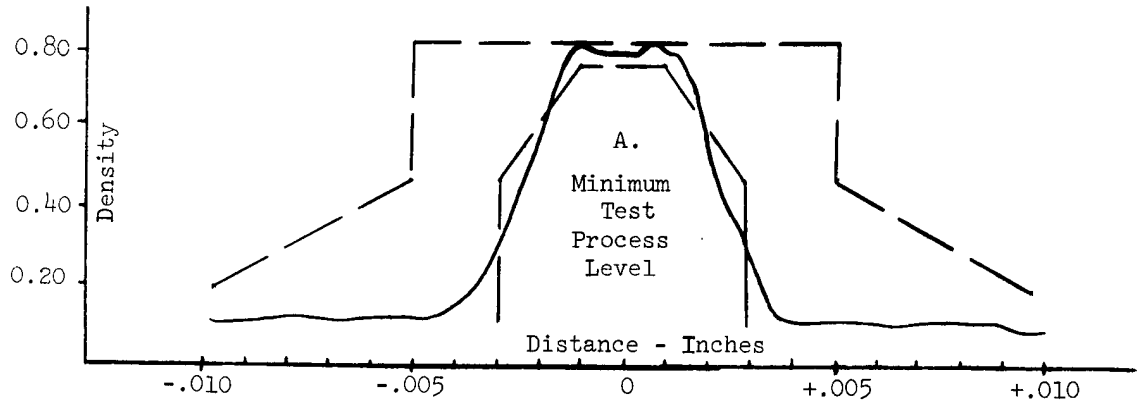
Figure 3

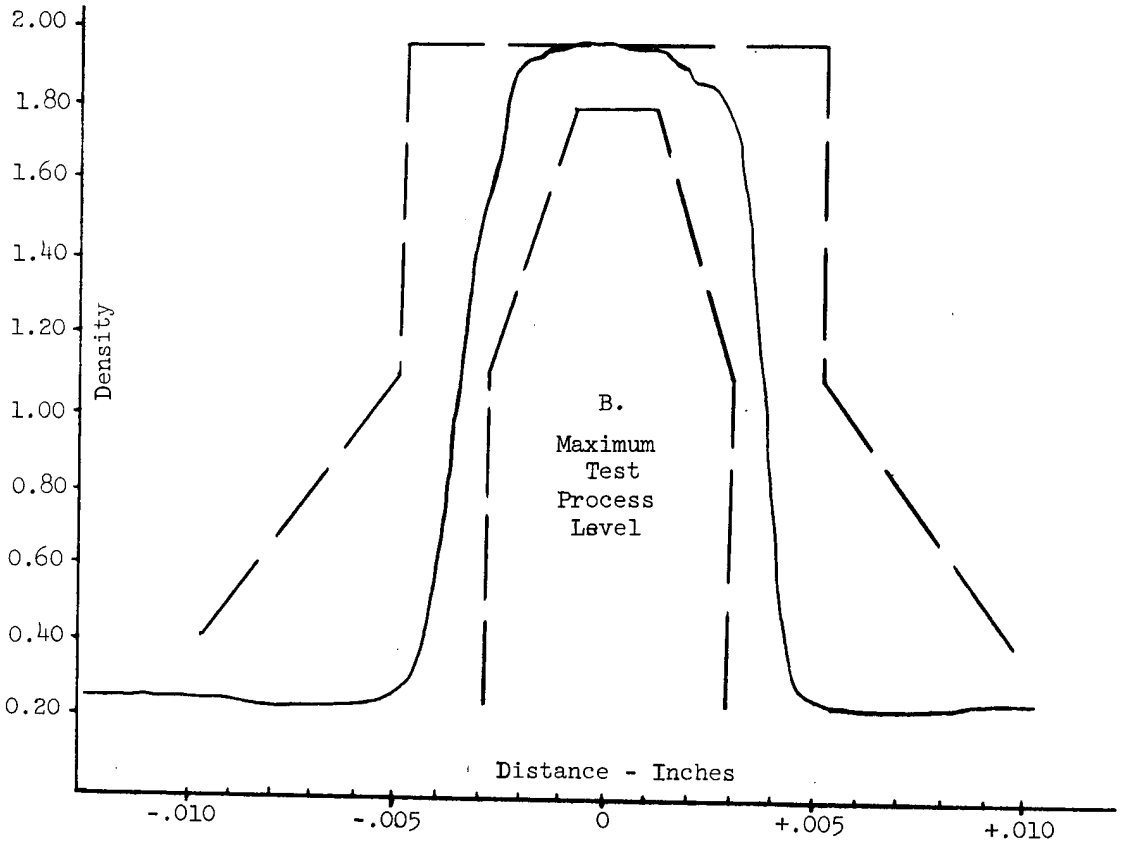
Extreme Range of Dot Densities from Process Levels Tested

(Format 12 Test Material)



——— ——— ——— Density Tolerances as Defined by MIL STD 782B

——————— Microdensitometer Trace



conditions (maximum and minimum process levels tested) and indicate the range of density profiles evaluated.

6. Test Procedure. The procedure used in this evaluation program is outlined schematically in Figure 4. Some of the important features of this test procedure are as follows:

a. Bit-by-bit Comparison. In order to evaluate the reliability of the reader and check the performance of the paper tape error indicator, it was necessary to compare the reader magnetic tape output data (bit-by-bit) against the actual data on the film. The number of code dots in a single run on the reader is a four decimal figure. Therefore a computer program to accomplish this task was written for Format 12 data test material and debugged for use with the 360 computer.

b. IBM Truth Deck. The specific code dot configurations in each data block of the master test materials were documented by visual examination. This information was then key punched on IBM data cards to make up a data "truth deck" which was used in the final evaluation of the Fairchild reader output.

c. Master Test Rolls. Various methods of reproducing the master test rolls (changes in contrast and polarity) were obtained by using different duplicate film types. Type SO-107* was used to produce high-contrast duplicate copies; Types 2430* and 2420* were used for intermediate contrast, while Type SO-233* provided low-contrast reproductions. Type SO-239* was employed to obtain negative reproductions directly from the original negative. Direct reversal duplicate negatives were of special interest because the reader manufacturer, as well as the initial tests, indicated the instrument operated better with negative type imagery. A series of printing conditions were used with each method of reproduction, which resulted in a full range of both positive and negative dot density profiles.

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* Film materials used for this evaluation:

25X1A [redacted]

High Definition Aerial Duplicating Film (Gray Base), Type SO-107
Fine Grain Aerial Duplicating Film, Type 2430 (Estar Base)
Aerographic Duplicating Film, Type 2420 (Estar Base)
Low Contrast Fine Grain Aerial Duplicating Film, Type SO-233
Direct Duplicating Aerial Film (Estar Base), Type SO-239

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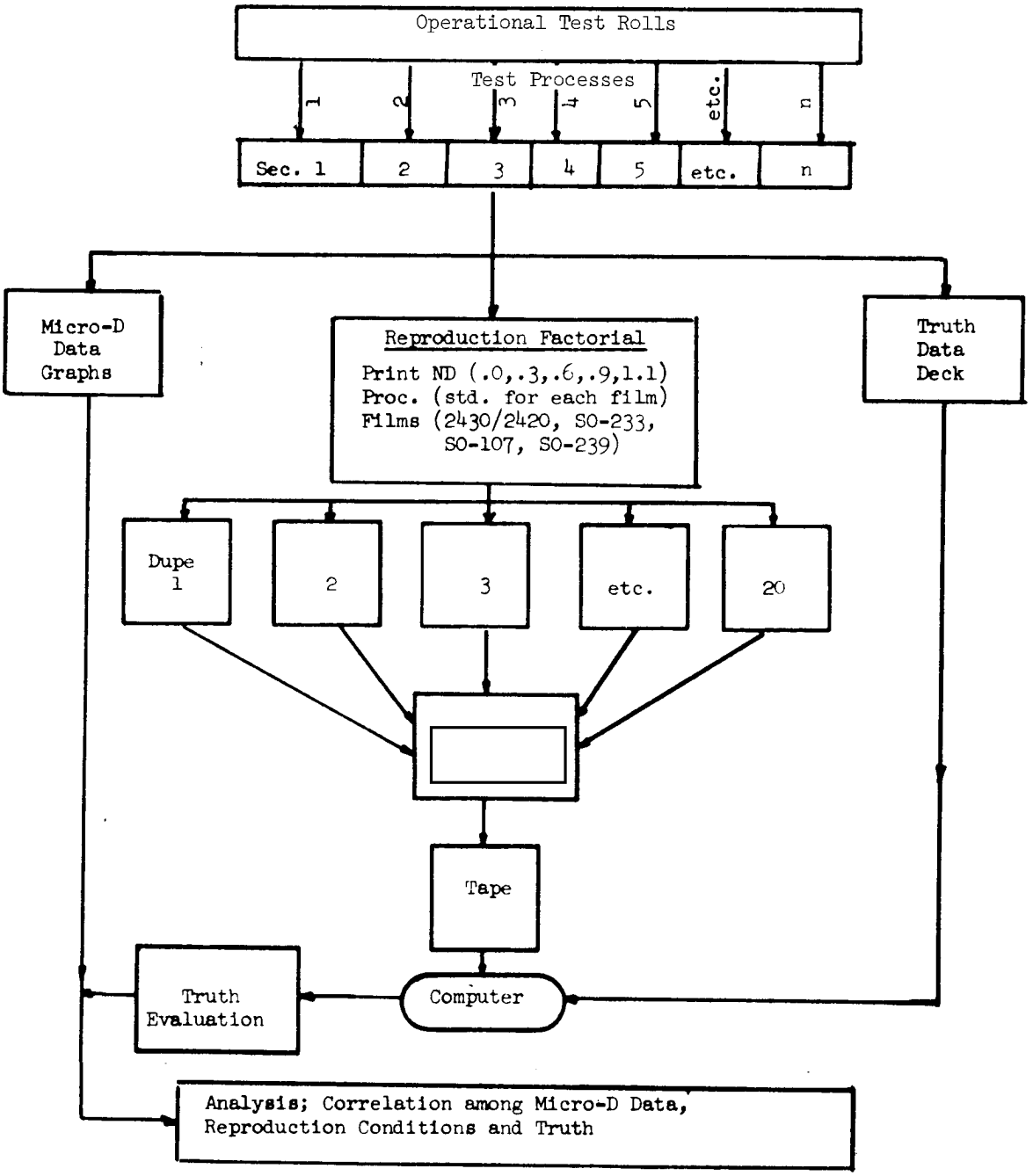
Figure 4

Test Procedure for [redacted] Data Block Reader

25X1A



25X1A

d. Errors from Paper Tape. Each printer series for the various methods of reproduction was tested on the [redacted] Reader. 25X1A The printed paper tape output from the reader would indicate the data blocks which contained readout errors. These were evaluated first, and if a satisfactory run was indicated, the output on magnetic tape was then saved for analysis on the 360 computer.

e. Computer Evaluation. The magnetic tape output along with the appropriate "truth deck" statements were fed into the computer for analysis. The computer output consisted of a bit-by-bit evaluation of each data block and listed the bits which were in error. This computer output along with the micro-D traces of the dots which were in error provided the necessary data to relate dot density profiles and reproduction conditions to the readability indicated by the reader.

7. Results/Performance

a. Duplicate Negatives Preferred. With the circuitry and light source of the [redacted] reader, data block reproductions which contained uniform background densities proved to be best for reliable readability. This explained the better performance with duplicate negative dot images. Images produced by various levels of original negative processing can be reproduced over a broad range of printing conditions to yield a duplicate negative with a uniform low density background. (With process level changes, the fog level of the original negative changes less than the peak dot density.) Acceptable duplicate positive copies, on the other hand, could be produced using a number of different materials and printing conditions. The best of these usually involve high contrast, low intensity printing. Duplicate negative copies, however, consistently gave the best results on the [redacted] reader. These duplicate negative copies, because of their high level of readability, were used for further testing of the instrument's performance.

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25X1A

b. Computer Analysis and Readability. Analysis with the 360 computer established the relationship between reproduction conditions and the readability of the data block images. The magnetic tape output

from the reader was compared with the "truth deck" of known data block configurations. An example of the computer output obtained from tests conducted with Format 12 material is included in this discussion to illustrate the use of the computer output as well as to document one of the problems encountered with the data block test material. Figure 5 shows a segment of the printed computer output from an analysis of Format 12 tests. Note that the only bits in error (circled) of the five data blocks shown are the 15th and 16th bits. The bit errors for several complete runs were tabulated on charts such as the one shown in Figure 6, where each mark (x) indicates a bit in error. The large number of readout errors in the region of bits 15, 16 and 17 called for a closer examination of those dots in that area. The presence of the "holey rail" dot exposure discovered near this region of the data blocks explained the frequent readout errors associated with these particular bits. The photograph in Figure 2 (Format 12) shows an example of this "holey rail" dot exposure which affects the readability of the data block dots.

c. "Holey Rail" Exposure. Once the correlation between the readout errors and the "holey rail" dots was established, it was possible to take into account those bits which were known to have been affected by this problem. The reliability of the reader could then be evaluated by discounting those errors associated with the "holey rail" dot exposures. When duplicate negative copies were evaluated in this manner, it was concluded that their readability with the [redacted] reader was greater than 95% reliable. The evaluation included copies generated from extremely underdeveloped data block test materials, as well as the normally processed dot images. This high level of reliability (verifying claims made by the reader manufacturer) has since been confirmed by subsequent tests with material exposed in a camera system without "holey rail" dots near the data block images.

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d. Error Indicator. As a result of the computer analysis, confidence was established in the paper tape error indicator. Read errors as indicated by the paper tape output were confirmed in every case by the computer analysis results. Also, each time the computer showed a data block with a bit in error, this agreed with the error block number printed

Figure 5

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Sample of Printed Computer Output from
Analysis of Format 12 Test Material

Note: Bits in error circled.

O's - indicate data dot configuration as read by [redacted] Reader

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X's - indicate actual dot configurations which comprise "truth deck"

RUN 2 RECORD 27 SAMPLE 70 3/ 7/68
X = TRUTH BIT ON
O = DATA BIT ON

RUN 2 RECORD 28 SAMPLE 69 3/ 7/68
X = TRUTH BIT ON
O = DATA BIT ON

RUN 2 RECORD 29 SAMPLE 68 3/ 7/68
X = TRUTH BIT ON
O = DATA BIT ON

BIT 15 DATA WORD ON TRUTH WORD OFF DATA WORD COMPLIMENT OFF

RUN 2 RECORD 30 SAMPLE 67 3/ 7/68
X = TRUTH BIT ON
O = DATA BIT ON

BIT 16 DATA WORD ON TRUTH WORD OFF DATA WORD COMPLIMENT OFF

RUN 2 RECORD 31 SAMPLE 66 3/ 7/68
X = TRUTH BIT ON
O = DATA BIT ON

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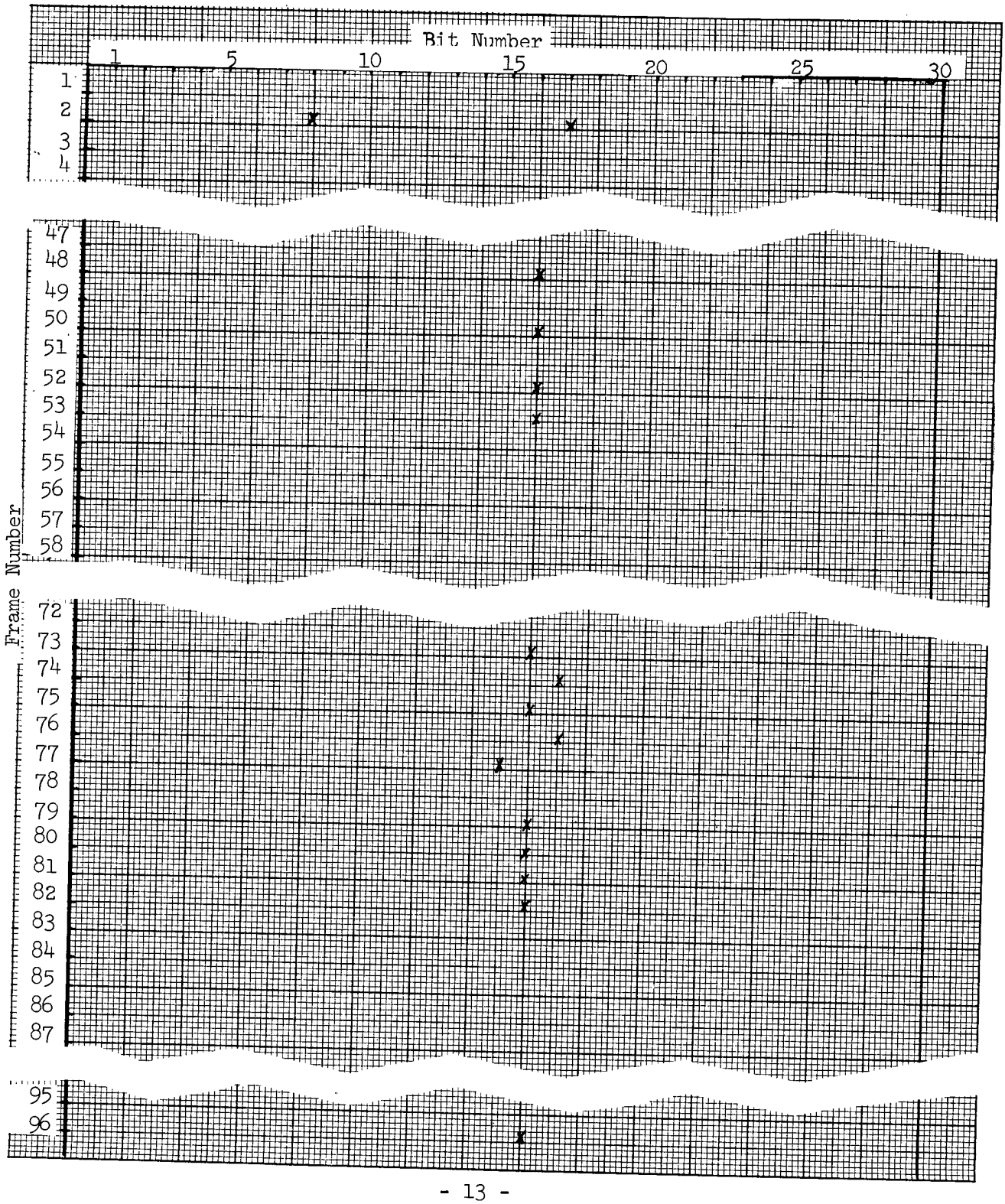
Figure 6

Data Block Error Tabulation Chart



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on the paper tape. Therefore, once this 100% agreement between the paper tape output and the computer results was established much of the remaining performance tests were evaluated without the aid of the computer.

e. Film Wander and Lamp Intensity. Two tests aimed at describing the performance of the reader were run to check on the film transport wander and determine the effect of the projection lamp intensity on film reading.

(1) Film Tracking Accuracy through the Reader

(a) Before each machine operation the row of index dots of the first code block are centered between two reticle lines by the operator (see Figure 7A). Adjustment is provided by a control knob geared to a rotational increment indicator. The units on the indicator are proportional to the linear travel of the code block. During adjustment the code block is viewed through a scope and, as is shown in Figure 7B, the viewer sees an inverted image. For the Film Tracking Test, the bottom reticle line was chosen as an arbitrary zero.

(b) Initially, the index row of dots was set 20 indicator dial units below this line. A duplicate negative test roll containing 91 frames (format 12 data blocks) was run through in the forward direction. All reading errors were recorded. At the end of the run the index position of the last code was noted with respect to reticle zero. The run was repeated in reverse direction without any further machine adjustment. Again, at the end of the run the index position for the first code was noted. This procedure was repeated after each advancement of the adjustment knob by 5 units until the index row reached the reticle's upper line.* The results of the tests are shown in Figure 8 for the forward runs and in Figure 9 for the reverse run.

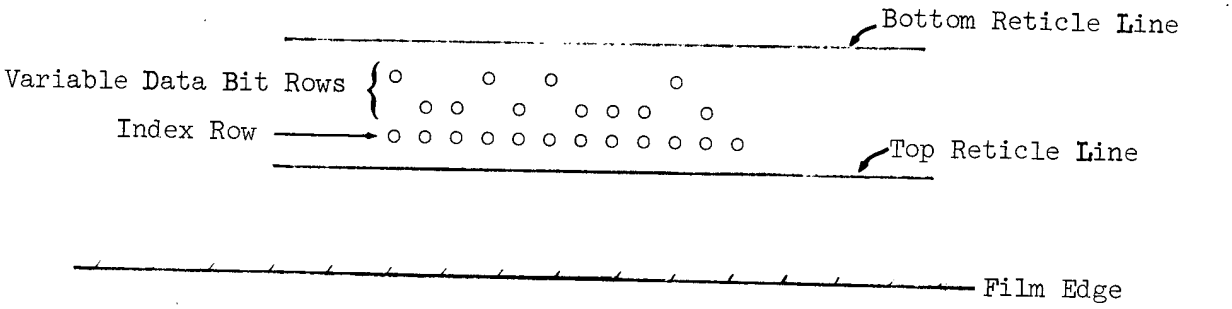
(c) The position of the first code index row and the last code index row are plotted for the two runs which started with the index dots on the reticle lines. The result in each case of forward and reverse run is about .020" of skew for the 91 frames. A separate measurement of the distance from the film edge of all 91 code blocks is tabulated in Appendix A. This also shows a drift of the code toward

* The beginning and end points of each run that started on a reticle line (top or bottom) are joined by a straight line in Figures 8 and 9.

Figure 7

Tracking Test Description

A: Data Block Configuration with Respect to Reticle Lines in Viewing Space



B. Position of Index Lines at Start and End of Run

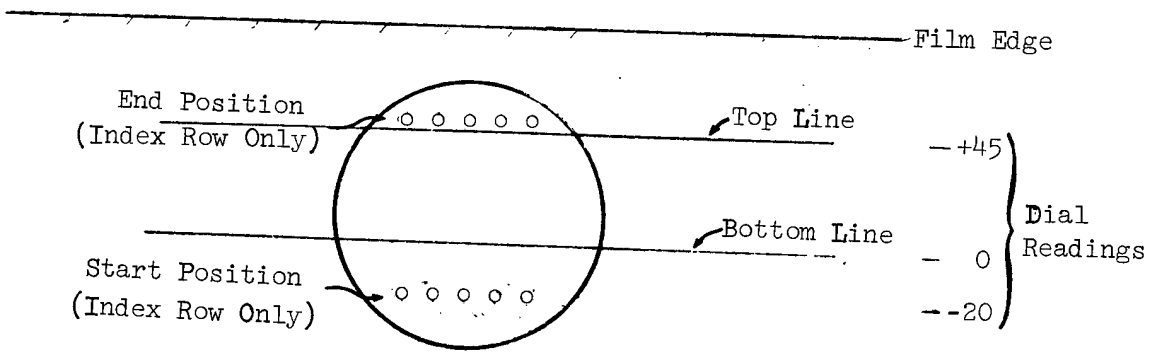
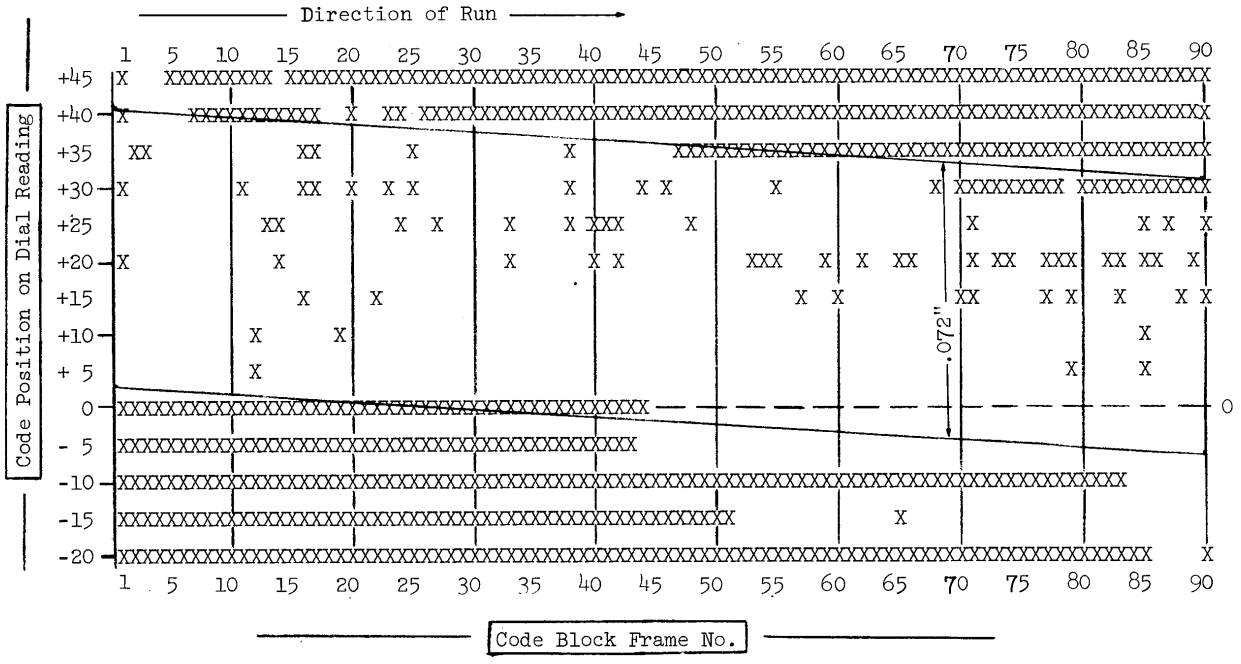


Figure 8

Reader Errors -- Film Transport Test, FORWARD RUN



(X) Indicates Reading Error

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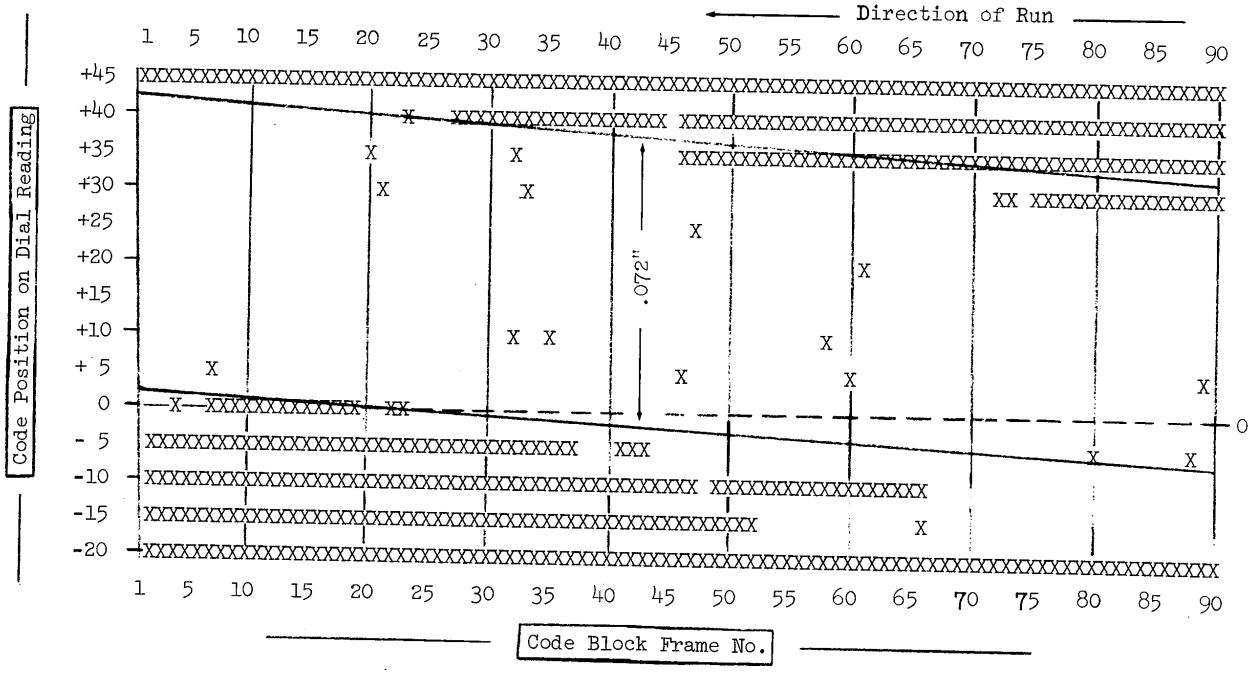
Figure 9

Reader Errors -- Film Transport Test, REVERSE RUN



(X) Indicates Reading Error

the film edge of about .020" from start to finish. The bulk of the relative code wander is thus attributed to the positioning of the code itself. Mistracking in the reader transport therefore is considered negligible.

(d) Tests show that a run in the reverse direction is significantly better than a forward run. This verifies information given by the manufacturer's representative, but no assignable cause for this effect was known by him or found by us during these tests.

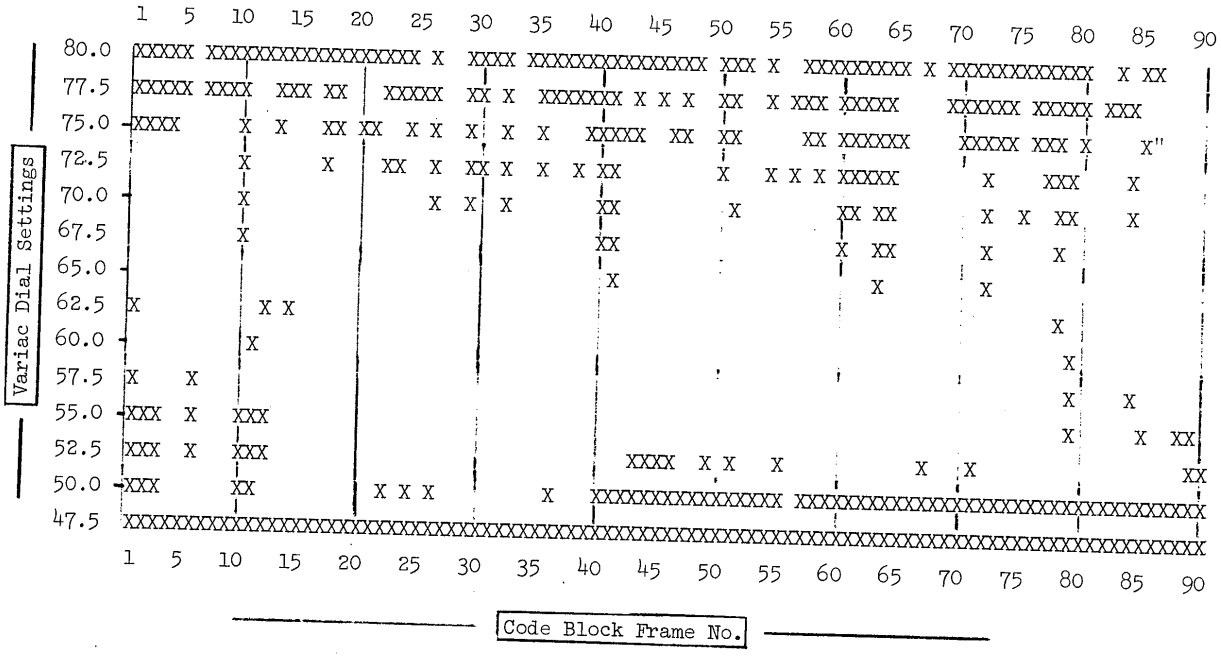
(2) Lamp Intensity Test. The effect of variation in lamp intensity on reading errors is shown in Figure 10. The same roll of 91 frames from the previous test was used with the code block adjustment set at the optimum position. The roll was run repeatedly with different settings of projection lamp voltage. The range of voltage variation without an increase in errors is from 5 to 10 percent. There is good correlation in errors from one run to the next as the intensity goes out of the tolerance range.

8. Operating Problems. Approximately 500,000 feet of test material was run on the equipment during the course of this evaluation. Only a few operational difficulties were encountered.

a. Metallic Starting Tab. In order to read the first data block in each roll, a metallic tab can be placed at the beginning which will trigger a photo-sensor and synchronize the reader. This start tab needs to be carefully positioned with respect to the first block of data. An inconvenience was encountered with these positioning tabs, when running repeated tests with the same film roll. The manufacturer's representative demonstrated an alternate method for setting up and starting the reader whereby the first data block is used as a starting point. With this method, the first block will always be in error but it avoids the problem of positioning the start tabs. As these tabs were not used during this program, the first data block in each roll was always discounted when evaluating a test run. However, during actual operation, the first data block in each roll must be read by visual

Figure 10

Reader Errors at Various Lamp Intensities
(REVERSE RUN ONLY)



(x) Indicates Reading Error

P68-3 and D68-15

examination unless the start tabs are properly placed on each of the rolls scanned on the reader.

b. Glass Film Transport. The optical glass "turtle back" film transport device that positions the dot images for reading requires periodic cleaning to prevent dirt and dust particles from interfering with the performance of the reader. As mentioned earlier, valuable original negative materials must never be scanned on the reader because this optical glass will catch some particles and scratch the film. During the 7 month period of operating this instrument, the effect on the glass from the consequent large quantities of film has been noticeable. If the abrasion of the glass continues and the condition reaches a point where the scratches interfere with the performance of the reader, the optical glass must be replaced.

c. Maintenance. There were no unusual maintenance problems encountered with the code reader during the 7 month period of operation. The running time is estimated at 10 to 16 hours per week during this time. The maintenance required is summarized below:

1st month - Replaced one circuit board

7th month - Replaced projection lamp,
Replaced small indicator lamp, and
Photo-sense (start-and-stop tab) was found out of adjustment.*

d. Conditions. Relatively low ampient temperatures must be maintained for the current design of the reader. A thermal cut-out exists on the magnetic tape unit which turns the reader off if the cabinet temperature rises above approximately 80°F.

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* Because the start-stop tabs were not used in testing, the photo-sense circuit was deactivated. The manufacturer intends to readjust this circuit when the Reader reaches its final destination.

CONCLUSIONS

9. The Multi-Format Data Block Reader has adequate capability for reading code data representing five different formats from current operational camera systems.

10. The reader operates better with negative images (high density dots with low density background) than positive images. However, valuable original negatives should not be used with this machine because the optical glass "turtle back" film transport device scratches the material.

11. Duplicate negative copies provide suitable data block reproductions for greater than 95% readability.

12. The indicator lights and printed paper tape error listings function well, and provide reliable indications of the readers performance. Bit-by-bit analysis of the reading errors based on visual examination of the code data showed 100% agreement with the printed paper tape error listings.

13. Tests were conducted to investigate operational characteristics of the film transport and the effect of lamp intensity adjustments. These tests show:

a. The film transport tracks the film across the head well within the reading tolerance of ±0.030".

b. The reading head is sensitive to intensity variations of the lamp. A change of 3 to 5 volts from the optimum level produces a significant increase in errors.

Note

14. This evaluation program involved running approximately 500,000 feet of film over a period of 7 months. During this time very few operational difficulties were encountered and maintenance requirements were light.

15. To expedite testing the machine was modified by the manufacturer so it was not necessary to use the metallic starting tabs. With this procedure, however, the first block always produces a readout error, and is therefore rejected during evaluation.

RECOMMENDATIONS

16. Use duplicate negatives rather than duplicate positives for reproducing data block images. This will assure maximum readability with the Multi-Format Data Block Reader.

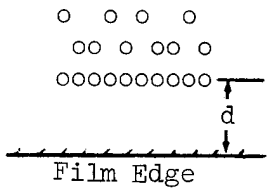
17. Do not use original materials with the current film transport device on this equipment. Valuable original negatives can be damaged by scratches from the "turtle back" glass transport device.

18. Employ a voltage regulator in conjunction with the light source to insure that line voltage variations will not influence the projection lamp intensity.

APPENDIX A

Separate Measure of Data Block Distances
from Film Edges for Test Roll of 91 Frames

Frame No.	d	Frame No.	d	Frame No.	d	Frame No.	d
1	.115"	26	.107"	51	.105"	76	.098"
2	.117	27	.112	52	.105	77	.097
3	.116	28	.110	53	.105	78	.097
4	.120	29	.110	54	.103	79	.097
5	.117	30	.110	55	.103	80	.097
6	.115	31	.110	56	.103	81	.097
7	.115	32	.110	57	.103	82	.096
8	.120	33	.110	58	.103	83	.095
9	.117	34	.110	59	.103	84	.096
10	.118	35	.108	60	.103	85	.097
11	.115	36	.108	61	.103	86	.098
12	.116	37	.108	62	.102	87	.097
13	.115	38	.110	63	.102	88	.096
14	.117	39	.108	64	.102	89	.096
15	.117	40	.108	65	.102	90	.095
16	.115	41	.109	66	.103	91	.097
17	.118	42	.108	67	.103		
18	.115	43	.108	68	.101		
19	.115	44	.108	69	.101		
20	.115	45	.108	70	.100		
21	.114	46	.108	71	.100		
22	.113	47	.106	72	.100		
23	.114	48	.105	73	.098		
24	.115	49	.105	74	.098		
25	.113	50	.107	75	.100		



.025 Variance

HANDLE VIA
TALENT-KEYHOLE
CONTROL SYSTEM ONLY

SPECIAL HANDLING

SECRET

HANDLE VIA
TALENT-KEYHOLE
CONTROL SYSTEM ONLY

SPECIAL HANDLING

SECRET

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